# TESTIMONY TO THE HOUSE TRANSPORTATION COMMITTEE

# HEARING ON ENERGY INDEPENDENCE AND CLIMATE CHANGE

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Thank you for providing the Commercial Aviation Alternative Fuels Initiative with the opportunity to testify on the compelling issues of energy independence and climate change, as it relates to Aviation. It is particularly satisfying to be represented on a panel with three of our sponsors (ACI, ATA, and UTC)

CAAFI is a data gathering and communications process that seeks to increase both the quantity and the quality of dialogue among its Airline, Airport, Manufacturer and FAA sponsors. It also seeks to engage multiple government, industry and university stakeholders. The fundamental belief of the sponsors in forming the CAAFI process is that aviation is data driven and relatively small in size allowing it to benefit from such a process. CAAFI's sponsors and stakeholders recognize that data they develop and collect, in the hands of key analysts and decision makers in such matters as safety, security, and the environment. will be a catalyst for informed and expedited solutions which serve all components of the supply chain well. Such clarity of solutions and message, it is believed, will spur suppliers to invest in solutions suitable for Commercial

Aviation. The goal is to make our relatively small sector of the transportation a "customer of choice" for alternative fuels. .

My role as Executive Director is simply to be the facilitator of that process. While I am an independent contractor to our FAA sponsor in this role, my task is to balance the interests of all four supply chain sectors.

With this in mind two areas will be covered in during this testimony.

First, information that is either available today to CAAFI for joint dissemination, or is in the process of being developed, regarding alternative fuel candidates for aviation will be reviewed. Aviation is more limited in the range of fuels that it can use than other transportation modes. Solutions for aviation in this testimony will be limited to non-renewables from sources other than oil and to renewable bio fuels. These are the liquid fuel types, which have an opportunity to succeed as they can be compatible with existing aircraft and have an opportunity to meet the rigorous safety and performance standards of aviation. .

Second, and more briefly, the workings of the CAAFI process and how it brings together its airline, airport, manufacturer and FAA sponsors and the stakeholders that interface with these entities will be explained. Particular emphasis will be placed on the role of the CAAFI environmental team. This is a key focus of the hearing and a unique expertise that it is believed CAAFI sponsors and

stakeholders have in aviation arena. The testimony will conclude with brief thoughts on how going forward plans are being structured within the FAA in particular to continue CAAFI's efforts.

Information presented in these areas represents what CAAFI's sponsors and stakeholders have contributed to this joint activity during since the outset of its very brief existence (since 10/06). Regard this input is very much a snapshot of unfolding events. Do note the date! Events and new results arrive and are conceived almost daily in this rapidly developing focus area. Some of these developments are proprietary in nature and not shared among all sponsors and stakeholders.

Aviation Alternative Fuel candidates presently being examined begin with largely non-renewable (coal and gas) sources near term (0 to 5 years). As can be expected there is far more data available on these sources and consequently more information that will be discussed regarding both technical and business perspectives.

In the near to mid-term (5 to 15 years) bio-diesel renewables and some more difficult to extract non-renewable sources such as shale oil are possible according to the USAF scientific advisory board. Blends of renewable and non-renewable sources can be brought in play in this time period. Some analyses of

how deployment can be effective in this area have been brought to CAAFI's attention and will be addressed.

Long term (15 years and beyond) Bio-fuel renewable candidates from a variety of alternative processes could be targets for aviation use. The range of possibilities being examined is extensive and many efforts are being executed at a small scale level as it applies to aircraft applications.

The most immediate opportunity for alternative fuels for aviation are derived from Fischer Tropsch processes. These processes convert alternative hydrocarbon bearing feedstocks (mostly renewable and non-renewable solid materials) to essentially identical hydrocarbon chains that are used in jet aircraft. For this reason they are classified as "drop in" replacements. "Drop in" means that these fuels are interchangeable with, and can be mixed with, today's jet fuel. There has been extensive testing of some of these fuels and there are no known consequences to aircraft and engine performance or airworthiness in candidates that have been received extensive attention of qualification/certification authorities. .

A key step in FT processes not found in oil refineries, and important to the climate change discussion, is the gasification of solid feedstocks. That process does produce more C02 than is produced in an oil refinery. Hence the capture, use and/or storage of that C02 is critical. While Fischer Tropsch processes have

been in use since the 1920's improvements in efficiency, proprietary process catalysts that are used, and the ability to capture and sequester C02 are relatively straight forward commercialization will be dependent on added clarity in public policy according to sources available to CAAFI.

Two specific Fischer Tropsch candidates, coal and natural gas derivatives are on a track to be qualified for aviation use as early as the middle of this year.

The first of these candidates is 50/50 blend derived from natural gas is produced by Syntroleum. This candidate completed testing on a USAF B-52 aircraft last year. Qualification is possible by mid-year.

The second candidate a 100% a coal derived liquid fuel from South African Company, Sasol, completed testing with a combustor test for emissions in January. Engine Manufacturers Pratt and Whitney, Rolls Royce and Honeywell conducted this battery of required checks in test facilities and on commercial aircraft.

Both of these candidates were tested and are being evaluated to establish conformance with performance, durability and emissions characteristics under protocols developed by ASTM (the American Society for Testing and Materials Standards).

The current plan of CAAFI's FAA Air Worthiness led Certification/Qualification team; working with USAF over the next year is to create a generic specification for FT fuels. For this purpose the two candidates above, along with other fuels available at the laboratory level and having similar characteristics, will be examined. The goal is to allow any producer who meets the aviation fuel specification requirements, in addition to the two above, will be able to bid on initial procurement contracts forthcoming from USAF later in the decade

From and energy independence perspective first mover FT plant projects could come on line in the 2010 to 1012 time frame. These first mover facilities could economically provide up to 1/3 of their production for commercial aviation if plant economics are the sole factor.

From a climate change perspective some, but not all, CTL first movers who have been in contact with CAAFI interests indicate that they will incorporate provisions for carbon capture and sequestration, and have markets available for C02 use (e.g. enhanced oil recovery).

There is also a growing intent to factor in some biomass capability to reduce CO2 exposure over the life cycle. Per studies executed by Princeton University this provision will place aviation fuel from FT Coal at about the same level as today's output resulting from refining Jet A. if only today's technology for gasification efficiency is assumed (ref 1). New technology now in the demonstration phase

by private industry and government can improve significantly on that outcome. Without such action the C02 production produces by CTL would be as much as 75% higher than Jet A production.. Again according to Princeton Studies inclusion of biomass feedstock at as much if 20% of the feedstock could place these facilities at levels significantly below jet fuel in life cycle C02 production of Jet A and approach carbon neutral outcomes..

While considering Climate Change and Energy Independence issues it is important to note four other significant factors associated with FT fuels..

First, FT fuel candidates have significant potential benefits in local air quality as they are regulated under the Clean Air Act in the U.S. Measured levels of small particles (PM2.5) have been measured at levels 50% to 90% better than JP8 during jet engine tests.

As they are sulfur free FT fuels can be used in Ground support equipment as a diesel substitute. This raises the possibility that the number of fuels used at airports could be reduced coupling economic benefits with environmental gain. A tool to allow airports to assess the potential environmental and economic gains associated with these factors is currently being executed via a CAAFI inspired project under the Airport Cooperative Research Program (ref 2)

Second, recent studies executed by Scully Financial (ref 3), under contract to DOE and USAF are showing FT CTL to be in a reasonable cost ballpark (< $60 / barrel crude equivalent) even when the cost of sequestration technology is included in plant cost.

The third and fourth points are words of caution.

While technically feasible, and while evidence of financial viability exists, availability of these fuels in quantities that will make a significant dent in aviation supply does not yet exist. Far more is needed to achieve energy independence than what could be available at current plant investment levels.

Most initial plants, that CAAFI are aware of average 30,000 barrels a day production. At this level maximum economies of scale are achieved in production while construction costs can be minimized to a mere $3 billion per facility. Assuming that maximum economic potential of 1/3 supply from IGCC plant fuel output goes to aviation sources this quantity is only $1/10^{th}$ the supply needed for daily operations at O'Hare. DOE's current inventory of planned CTL facilities lists only a dozen candidates (ref 4) some much smaller than 30,000 barrels per day and at locations remote from airport infrastructure. This is a start – but it is not energy independence.

Lastly the economics of blended biomass FT (from switch grass or other bio candidates) to achieve superior climate change benefits will likely require the development and predictability for a carbon trading market that will compensate the agricultural sector adequately for channeling crops in the direction of these fuels. This matter was studied in (Ref 1). The committee is referred to the Princeton authors of those studies for further details.

None the less, near to mid-term Fisher Tropsch solutions likely offer the best approach to the combination energy Independence and local air quality concerns. As noted they can have superior characteristics to limit climate change consequences compared to petroleum fuels production when Biomass is added to the blend and meet "drop-in" standards for today's aircraft.

That said, these candidates may not represent the best technical long term solution to address climate change concerns, particularly if adequate bio-mass supplies are not obtained. It is understood that in the next several months both USAF and DOE will provide significant new information on the technical and economic viability of FT CTL/biomass blends.

Biofuel production alternatives to Fischer Tropsch production could offer the best opportunity for C02 reduction. These are however further away in time, and could have several additional technical hurdles to overcome in applications to

aircraft. In addition little substantive information has been made available to CAAFI on production economics to date..

Biofuels are combustible liquids that are manufactured from renewable resources such as plant crops or animal fats. Crops with high oil content such as soybeans, rapeseed (canola), and sunflowers are the starting materials used to produce bio-oils or bio-oil blending components.

Several challenges exist for the use of current biofuels in commercial aircraft using conventional esterfication processes that are not issues when used in other transportation modes.. These fuel types have a propensity to freeze at normal operating cruise fuel temperatures, their energy content is lower than jet fuels causing sacrifices in payload and range. Thermal capacity – or the ability of the fuels to act as a heat sink – particularly in future aircraft that may require increased heat rejection requirements may be poorer than Jet A and significantly poorer than FT fuels.

Efforts to overcome these deficiencies and to maintain the current fuels standards could require changes to the aircraft – e.g. fuel heaters to compensate for freeze point changes and added heat exchangers. These compromises may give back portions of the C02 benefits achieved by requiring configuration changes that increase fuel burn, not to mention the capital costs to make these changes to aircraft. Study of the required scope of these changes is a CAAFI

high level study goal brought to the attention of NASA, FAA, USAF and CAAFI's University stakeholders for assessment..

An alternative approach to esterification of bio-fuels described above, which may add significantly to their attractiveness to aviation is the hydroprocessing of raw oil from plants. In this process, hydrogen is added to the fuel to remove oxygen atoms and to improve product stability. The resulting biofuel is a carbon/hydrogen fuel that looks very similar to petroleum jet fuel. The unique advantage of this approach is that the hydrogenation of the biofuel can be done in existing refineries or in combination with FT plants.

While hydroprocessing of plant oils may offer promise technically the business case at refineries creates additional processing steps and adds cost. In addition there will likely be significant competition for hydrogen to be used in this process. Information on the supply potential and the degree to which C02 based economics can contribute to making this candidate attractive have yet to be made available to CAAFI. It is a priority to obtain such data.

CAAFI's Certification and Qualification Teams will be seeking to increase its focus on a bio-fuels certification and qualification roadmap when it meets next month. One catalyst for this effort is the recent announced intent of Boeing, Richard Branson's Virgin Fuels and General Electric to pursue a 747 flight demonstration using bio fuels (ref 5)

A more complete discussion of Bio-fuels candidates is contained in a recent article from Boeing fuel specialist, CAAFI and ASTM member Oren Hadaller (ref 6). Much of the technical information on bio-fuels above is drawn from this ASTM paper.

While Commercial Aviation appears to be on track that will produce technical alternatives to commercial JET A and its Military equivalent JP8, commercial drivers for fuel suppliers to produce alternative aviation fuels in adequate quantities are more difficult to come by.

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As 5 to 10% user of transportation fuel the commercial aviation industry, aircraft manufacturers, airports, FAA and most specifically airlines must be highly focused and consistent in their message to fuel suppliers if they are to be an early "customer of choice" for the supply sector. In spite of its relatively small size as a consumer the concept that aviation had the potential to achieve this goal motivated the formation of the Commercial Aviation Alternative Fuels Initiative (CAAFI) by user entities.

CAAFI Sponsors believe that the aviation enterprise with its relatively compact size, global reach, and well articulated supply security and stability needs, and data driven focus are well positioned to achieve "customer of choice status". CAAFI is a process that simply facilitates needed data generation and the

maintenance of an efficient means of delivering that data to enable informed decision making by our component entities.

The CAAFI process uses four panels to channel the expertise of its sponsors as well as the multi-disciplinary stakeholders that compose 80% of its manpower pool. These panels consist of an R&D panel, a certification/qualification panel and a business /economics panel and an environmental panel. Three of these panels have created roadmaps to communicate and to guide their activities. An executive summary detailing CAAFI's mission and how it is organized to execute its mission (ref 7) is available upon request. For the purposes of this hearing it is appropriate to discuss the activities of CAAFI's environmental panel in greater depth.

Dr. Lourdes Maurice, Chief Scientist of the FAA's Office of Environment and Energy, leads CAAFI's Environmental Panel. Primary to the Environmental Panels mission is a full life cycle analysis of a variety of alternative fuel options being evaluated over their entire life cycle from raw material to engine exhaust. Much of the life cycle effort is being executed by the FAA's MIT led PARTNER Center of Excellence with Cost sharing support from major OEM's Boeing, GE and Pratt & Whitney. The PARTNER Analysis is currently in its initial phase. Once complete PARTNER will also provide tools to the enable the extension of FAA's emissions prediction tools used by airports and airlines, to alternative fuels. In addition these tools are and will be used by airports in the execution of

benefit /cost analysis handbook by the Transportation Research Board under the Airport Cooperative Research Program (ACRP).

Going forward in FAA's reauthorization proposals both efforts to maintain an Alternative Fuels function at levels elevated from FY07' are provided in the FAA's CLEEN proposal. An increase in the ACRP program is also included in the Reauthorization. Both are crucial to CAAFI and Aviation's overall success in the arena of alternative fuels..

Thank you again for recognizing the CAAFI process as a an instrument seeking both Energy Security and Climate Change gains. We welcome further inquiries on the subjects covered above and other matters related to alternative fuels.

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Ref 1. "Co- Production of Synfuels and Electricity from Coal+biomass with Zero Net Carbon Emissions: A case Study for Illinois" Robert Williams, Princeton Environmental Institute, Princeton University" presentation to DOE Sixth Annual Conference on Carbon Capture and Sequestration, 5/9/07.

Ref 2. "ACRP 02-07 [RFP], Handbook for Analyzing the Costs and Benefits of Alternative Turbine Engine Fuels at Airports", Robert E. David, Transportation Research Board , 4/25/07

Ref 3. "The Business Case for Coal Gasification with Co-Production - An Evaluation of the Business Risks and Potential Incentives for Early Commercial Gasification with Co-Production Project", Brian Oakley, Director, Scully Financial Services, USAF Energy Forum, March 9, 2007.

Ref 4. "Summary of Activities for Coal-to-Liquid Fuels, Section II – Projects – Existing and/or Proposed, Status of May 3, 2007" prepared for: DOE Office of Sequestration, Hydrogen, and Clean Coal Fuels, by: Technology and Management Services, Inc., Leonardo Technologies, Inc. and Mitretek Systems, dated 5/4/07.

Ref 5 Publication, Jet Fuel Intelligence ©, Vol. XVIII, No. 17 "Boeing's New Deal with Virgin Envisions Biojet for Aviation" Christina Haus, April 30, 2007

Ref 6. Smartbrief, ASTM Standardization News, "Alternative Aviation Fuels" April 2007, Orren Hadaller, The Boeing Company.

Ref 7. COMMERCIAL AVIATION ALTERNATIVE FUEL INITIATIVE (CAAFI), Process Mission/ Background / Goals / Accomplishments, Richard L. Altman, Executive Director, CAAFI, March, 2007